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16. ABSTRACT

In constructing a stable and durable asphalt concrete pavement, it is imperative that the mixture be correctly designed and properly compacted during the laydown operations. In the design of the mixture such points as grading of the aggregate, particle shape characteristics and surface texture, absorption of asphalt by the aggregate and optimum asphalt content are important considerations. In the laydown operations, temperature of the mix and type of compaction equipment and air temperature are of the utmost importance. If, in the finished pavement the so-called void content is high, particularly if the voids are interconnected, the passage of air and the admittance of water during inclement weather may adversely affect the durability and ultimate life of the pavement mixture. The presence of air in a permeable pavement contributes to the rapid hardening of the asphalt binder primarily through oxidation and evaporation and has been cited extensively in the asphalt literature. This paper deals primarily with construction practices which in turn influence the water permeability of the pavement. Water entering the pavement may not necessarily harm the structural section if free drainage is provided. The entrapment of water in the upper portion of the structural section however, may provide the medium for movement of colloidal fines from the base material into the intimate parts of the pavement mixture under even moderate deflections induced by traffic.

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STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

STUDIES ON WATER PERMEABILITY OF ASPHALT CONCRETE PAVEMENTS

By

Ernest Zube

Supervising Materials and Research Engineer

61-02

Presented at the Fourth Annual Highway Conference, University of the Pacific Stockton, California, March 7-9, 1961

March 1, 1961

Studies on Water Permeability of Asphalt Concrete Pavements

By

Ernest Zube*

Introduction

In constructing a stable and durable asphalt concrete pavement, it is imperative that the mixture be correctly designed and properly compacted during the laydown operations. In the design of the mixture such points as grading of the aggregate, particle shape characteristics and surface texture, absorption of asphalt by the aggregate and optimum asphalt content are important considerations. In the laydown operations, temperature of the mix and type of compaction equipment and air temperature are of the utmost importance. If, in the finished pavement the so-called void content is high, particularly if the voids are interconnected, the passage of air and the admittance of water during inclement weather may adversely affect the durability and ultimate life of the pavement mixture. The presence of air in a permeable pavement contributes to the rapid hardening of the asphalt binder primarily through oxidation and evaporation and has been cited extensively in the asphalt literature. This paper deals primarily with construction practices which in turn influence the water permeability of the pavement. Water entering the pavement may

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not necessarily harm the structural section if free drainage is provided. The entrapment of water in the upper portion of the structural section however, may provide the medium for movement of colloidal fines from the base material into the intimate parts of the pavement mixture under even moderate deflections induced by traffic.

During the past years, the California Division of Highways has performed investigations on a number of failures of asphaltic concrete pavements. In the majority of cases, these evidences of failures are in the form of "chicken-wire" cracking in the wheel tracks of the travel lane and are almost always associated with areas of high deflection. It is quite easy to explain the finding of fine material on the crack faces and at the surface of the pavement, since surface water will enter such cracks and if colloidal fines are available at the surface of the base or within the base, such materials may be pumped upward by the action of heavy loads.

On a number of failures, we noted that on breaking a chunk of pavement or intact core from the failed area, the colloidal fines were often found in the intimate part of the mix and on one specific job the entire level course and lower part of the surface course were completely infiltrated with fine material with no signs of surface cracking. These field observations led to the conclusion that such pumping action might be taking place without any evidence of surface cracking. Further study indicated that the water causing this action was not coming up from the base or subbase but must be originating from surface water percolating downward through the permeable pavement during rains.

At the present time our findings provide considerable evidence that the movement of water or water bearing fines is detrimental to the pavement. Where this condition has occurred we have consistently found a very high rate of hardening of the asphalt binder. Furthermore the infiltration of fines into small cracks of the pavement mixture created by traffic stresses will considerably reduce the cohesion of the mixture and will also prevent any possibility of "healing" during summer temperatures. The increase in moisture content in the structural section because of entrance of water from the surface may be sufficient, when combined with capillary water from below, to cause serious and early distress. We have, therefore, concluded that it is important to try to prevent the entrance of water through the surface.

In order to guard against excessive voids or porosity of the pavement, many organizations specify some minimum relative compaction of the finished pavement, the percentage of relative compaction being measured against some standardized laboratory compaction.

In order to determine this relative compaction, it has been necessary to obtain samples of the compacted mixture by either chipping out blocks or obtaining a core. Although both methods have been used with some degree of success, there are definite drawbacks. In breaking out a block, the compacted mixture is very often disturbed which may lead to erroneous results in the specific gravity determination. When obtaining cores by drilling, water is introduced into the specimen which requires considerable time to dry the core at low temperature. This causes some delay in determining relative compaction results.

From our field studies it became evident that a rapid method of measuring permeability of pavement surfaces was needed. After a review of existing methods, we decided that a more simple approach was required in order to obtain sufficient readings in a relatively short period of time. The purpose of this report is to present our most recent method for measuring the water permeability of asphaltic concrete pavements and to discuss the factors that influence the permeability during construction and service life.

Test Method

In our preliminary studies, we noted that water poured on a new asphaltic concrete pavement does not readily wet the surface and very little enters the mix. Later studies showed that traffic action, together with the presence of dust on the surface, tends to change this interfacial tension relationship and water will readily enter a permeable surface during the first rains. The problem of making a test was solved by the use of a small amount of detergent to reduce the surface tension of the water used in the test. On a number of jobs involving a relatively impermeable base, such as cement treated base, the values obtained by the use of this method have been correlated with the moisture content in the mix following rains.

The present test method is detailed in Appendix A. The equipment comes assembled in a compact kit and is readily portable. It was originally developed in connection with Seal Coat Studies* and has been in use by this department for the past four years. Briefly the test is performed by forming a small reservoir by means of a "grease ring" around a previously marked 6" circle on pavement. The ring may be easily laid with a grease gun using ordinary cup grease or completely formed in one operation by a special gun. The ring grease is sealed to the surface by running the finger around the outside edge of the grease. A special burette containing the test solution is placed beside the ring and the operator feeds the solution into the area within the ring, starting a stop-watch at the start of flow of the liquid from the burette. The area within the ring is kept moist during a test period of two minutes. The film of liquid in the ring should only be thick enough to present a glistening appearance. In other words, the test is conducted under zero pressure. At the end of the two minute

* "Seal Coats - Laboratory Contribution Toward Better Performance", by E. Zube. Presented at the 37th Annual Meeting of the Highway Research Board, Washington, D.C., January 1958. Published in Highway Research Board Bulletin 215, 1959.

period the total solution used is divided by two and the permeability reported in ml/min for a 6" diameter circle.

Surfaces that are covered with an open graded mix may also be tested by chipping away the open graded mix just outside of the six inch ring, down to the dense graded surface. The area removed is about 1/2" to 3/4" wide. This annulus is filled with the grease to form the seal and the permeability is determined through the open graded mix within the area of the ring. We have found it necessary to perform the test in this manner, since removal of the open graded surface with a chisel within the ring area tends to seal the underlying surface with a glaze of asphalt.

Our present practice is to perform tests successively at intervals of 25' in the outer and inner wheel tracks and at a point midway between. A total of six readings constitute a "set" for any one area, and the average is obtained. A series of these sets should be obtained over the length of the job.

To determine the permeability of an existing roadway it is essential that areas of the pavement which are subjected to only minor traffic be checked. On a freeway, one of the important areas for checking should be between the wheel tracks in the passing lane. It should be noted that an initially high permeability of a pavement may be reduced to a satisfactory value in the wheel tracks by traffic action. However, the between-wheel-track areas may remain quite close to their original values and water may enter here and cross-flow through the pavement and on top of the base and collect beneath the wheel track areas.

Factors Influencing the Permeability of the Pavement During Construction and Service Life

Our field studies have uncovered a number of variables that influence the permeability of the pavement during construction and its service life.

The most important variable during construction is the temperature of the mix and the compaction process which in turn will depend on the type and weight of rollers, amount of rolling and method of laying the mixture. Other variables, such as asphalt content and grading are assumed to be taken care of in the mix design.

The method of placing the mixture may influence the permeability values transversely, across the lane, as shown in Figure 1. In the normal paving procedure with end dump trucks the initial permeability is generally higher in the future wheel track areas, probably due to some segregation of the mixture near the edges by the lateral distribution device in the paver. However, this is reversed when the bottom dump method is used. There is apparently a greater amount of segregation in the latter method and this is manifested by a higher permeability value immediately in back of the pickup or conveyer equipment of the paver.

Thorough compaction is a very important factor in the ability of an asphaltic concrete pavement to resist destructive agents during its service life. In terms of permeability a most important part of the compaction procedure is to insure that the upper portion of the surface course is properly knit together. Experience has clearly indicated that traffic action is very effective in achieving this "tightening" of the surface and one reason for pneumatic rolling is to obtain this form of compaction during construction. Our incorporation of a pneumatic compaction requirement in the California Division of Highways 1960 Standard Specifications was based on the evidence that this form of rolling is a very effective way to reduce the permeability. We believe that adequate compaction in terms of density may be achieved by a heavy roller on the initial break-down pass and have, therefore, not required excessive weights for the pneumatic roller.

Some typical results of permeability-rolling combination studies are shown in Figure 2. We note an average reduction in permeability when increased rolling is used; however, it is not as great as expected. Unfortunately, because of the lack of equipment our pneumatic roller tire pressures did not exceed 35#/sq.in. However, on one job we were able to boost the tire pressure up to 50#/sq.in. and a notable reduction of about 150 ml/min was obtained when compared to the 35#/sq.in. tire pressure.

We plan to make further permeability and compaction studies during the coming construction season, especially with tire pressures up to 90#/sq.in.

The workability of the mix and ease of compaction will depend not only on field conditions, but also on mix design variables such as asphalt content and aggregate grading. Both variables will influence the permeability values and the differences between 4.5% and 5.5% asphalt on the same grading are shown in Figure 3 and are further illustrated in Figure 4, which shows the permeabilities after 18 months of traffic. It is of course realized that the proper asphalt content must be based on consideration of a number of factors and is limited by the stability requirements and in the case of non-critical mixes by necessary safe-guards against possible future "flushing" of the pavement with subsequent dangerous decreases in skid resistance.

Table A shows the relationships between asphalt content, permeability, voids and weight per cubic foot.

Figure 4 also illustrates the permeabilities after various time intervals. There was a noticeable reduction after application of the Fog Seal, a further reduction after winter storms, probably due to the fact that a small amount of water had entered the mix. In the spring the permeability increased after some of the water in the mix had escaped by evaporation due to higher air temperatures and then finally a marked reduction in permeability due to sealing of the surface by traffic action.

Our field studies have revealed that the individual permeability values may be quite variable even though every effort is made to control all aspects of construction procedure within the test section. A typical illustration of this is shown in Figure 5 indicating that average values should be used as an index to rolling adequacy. There is a reduction in permeability during at least the first 24 hours after completion of rolling, Figure 6. This is best accounted for on the basis of "cold-flow" of the binder since the test section was not subjected to any traffic. It is reasonable to infer that a number of original interconnected passageways are sealed at different points by the continuing movement and adjustment of the binder.

The importance of traffic action is shown in Figure 7. This striking reduction in the permeability of all areas of the roadway to a very uniform and low level has been found on a series of jobs paved during the early summer and subjected to traffic during warm weather. On another job, constructed in December, we found no reduction in the initially high permeability values until the following summer. Moisture contents obtained from samples in the outer wheel track of the passing lane showed enough moisture to cause partial stripping of the lower portion of the level course even though deflections were low. Base and subbase moisture determinations clearly indicated that the moisture content was due to entrance of rain water through the pavement.

During the late fall and winter paving, the lower atmospheric temperatures are a definite problem in attaining proper compaction. Even elevated mixture temperatures and immediate traffic action will not satisfactorily knead or seal the surface of the pavement to prevent entrance of water. Table B shows permeabilities obtained during paving operations in September and October-November on the same project. The September permeabilities average about 47 ml/min against 371 ml/min for the October-November values.

Also there appears to be a relationship between water permeability and the moisture found in the actual pavement after the winter rains as shown in Table C.

The Materials and Research Department of the California Division of Highways has consistently maintained that cold and inclement weather is the most adverse and least controllable factor affecting success or failure during the placing of a bituminous pavement or Seal Coat.

Based on California weather conditions, particularly in the northern part of the State, we have suggested the following tentative schedule for placing bituminous pavements or Seal Coats:

(a) Seal Coat construction using emulsified asphalts should be terminated by September 1st.

(b) Seal Coat construction using cutback asphalts of the rapid curing type may be extended until October 15th.

(c) Asphaltic concrete mixes, both open and dense graded might be carried on until December 1st although a November 15th deadline would be preferable.

A number of preliminary studies have shown that the normal Fog Seal will be effective in sealing a pavement only if the original permeability is fairly low. Figure 8 shows the reduction in permeability by the application of a Fog Seal. Readings were obtained before and after Fog Sealing at identical spots. We note that the permeability after Fog Sealing tends to parallel the original curve. It is logical to assume that the relatively large diameter passageways will not be sealed by the application of a small amount of asphalt and, therefore, in areas of high permeability no real improvement will be noted.

On the other hand, a Slurry Seal or Screening Seal Coat reduces the water permeability value to very low figures and virtually renders the pavement impermeable. See Table D and Figure 9. To all intents, the present method indicates that such seals completely prevent the entrance of surface moisture. Unfortunately, it is very difficult to attain a satisfactory job with either of these types of Seal Coats during cold or inclement weather though it is during this paving period that newly laid pavements are most in need of some form of sealing.

Tentative Limits for Permeability

We tentatively believe that an average water permeability value not exceeding 150 ml/min for a 6" diameter area will prevent the entrance of excessive moisture into the pavement from the surface. On the basis of field studies we have noted that a relatively low percentage of moisture may enter from the surface and not do any particular harm to the structural section. This moisture increase is not reflected in free water at the base level course interface and does not appear to contribute free water for pumping action. It should be noted that the stated figure is an average value, and some areas of the pavement will have definitely higher values than the average. If the pavement is laid during the summer paving season, the higher permeability values will be reduced to a quite uniform low value prior to the start of winter rains providing the pavement is subjected to traffic.

On the basis of our studies, pavements constructed in the late fall or winter and showing high permeabilities, will not show reduced values until the following summer. How serious the detrimental influence of water entering the pavement during the first winter is, and its effect on the reduction of the ultimate durability and service life of the pavement, can not be definitely answered at this time. However, there is sufficient evidence that a highly permeable pavement, constructed with California asphalts, has a reduced service life.

Conclusions

A simple rapid method for measuring the tendency of surface water to enter an asphaltic pavement has been developed.

The results of field studies, clearly indicates that pavements even of so-called dense graded mixtures have been constructed that are very permeable to the entrance of surface water. This water may contribute to possible failure of the pavement by acting as the agent for transporting base dust and clay fines into the intimate interstices of the pavement mixture, and this action may contribute to the rapid weathering of the binder, especially in the lower part of the pavement.

Field studies indicate that adequate compaction, especially some form of pneumatic rolling, is a very important factor in obtaining a satisfactory permeability value. Also the permeability value may continue to decrease immediately after construction and will definitely decrease for pavements laid during the normal paving season when subjected to traffic during the summer months. On the other hand, pavements laid during the late fall or winter must rely on adequate initial compaction since no further decrease in permeability may be expected before the following summer. Bituminous pavements or Seal Coats should not be placed in the late fall or during the winter months.

Fog Seals will decrease the permeability but will not prove effective if the initial permeability is very high. Slurry Seals and Screening Seal Coats effectively reduce the permeability value to a very low figure.

Most of these studies involving relatively permeable surfaces, were conducted on pavements constructed under the 1954 California Standard Specifications, and for that reason our 1960 Standard Specifications carry more rigid requirements, such as temperature control and additional compaction equipment in order to reduce the air and water permeability of asphalt concrete pavements.

Acknowledgments

The investigations described herein were conducted under the general direction of Mr. F. N. Hveem, Materials and Research Engineer, California Division of Highways.

The writer wishes to acknowledge the help and full co-operation of the many resident engineers on whose jobs these investigations were carried out. Special acknowledgment is due Messrs. John Skog, Merle Nelson, Glenn Kemp and Rufus Hammond who were active in the field and collected much of the data.

TABLE A

Physical Properties of Pavement Cores
Compared with Field Permeability
Values on a Single Contract

Sample Description	Asphalt Content %	Field Perm. ml./min.	Specific Gravity	Relative Comp. %	Wt. per cu.ft	Voids %
Core A	4.5	200	2.24	97.4	140	8.8
Core B	4.5	230	2.23	97.0	139	9.0
Core C	4.5	417	2.24	97.4	140	8.8
Core D	4.5	510	2.15	93.5	134	12.3
Stand. Lab. Compaction Field Mixture	4.5	-	2.30	100.0	143.5	6.2
Core E	5.5	30	2.31	98.3	144	4.5
Core F	5.5	70	2.28	97.0	142	5.8
Core G	5.5	250	2.19	93.2	137	9.5
Core H	5.5	250	2.22	94.5	138.5	8.2
Core I	5.5	550	2.18	92.8	136	10.1
Stand. Lab. Compaction Field Mixture	5.5	-	2.35	100.0	147	2.8

TABLE B

Average Permeability Values for a Pavement Constructed During Changing Climatic Conditions

Paving Date	Atmospheric Temperature Range During Paving		Average Permeability Ml./Min.
	Max.	Min.	
Sept.	87	51	47
Oct. Nov.	56	35	371

TABLE C

Permeability of Pavement Immediately After Construction Compared with Moisture Content in Pavement And Base After Heavy Winter Rains

Permeability Measurement Date	Permeability Ml./Min.	Sample Date for Moisture	Percentage of Moisture	
			Pavement	Cement Treated Base
Dec. 1956	10	March 1957	1.37	4.92
	10		1.50	5.35
	15		2.50	7.27
	35		2.96	6.99
	55		3.10	-
	105		2.69	-
	112		2.18	7.16
	170		3.14	4.71
	610		3.37	-

Average Percentage of Moisture in Paving Mixture During Construction = 0.2%

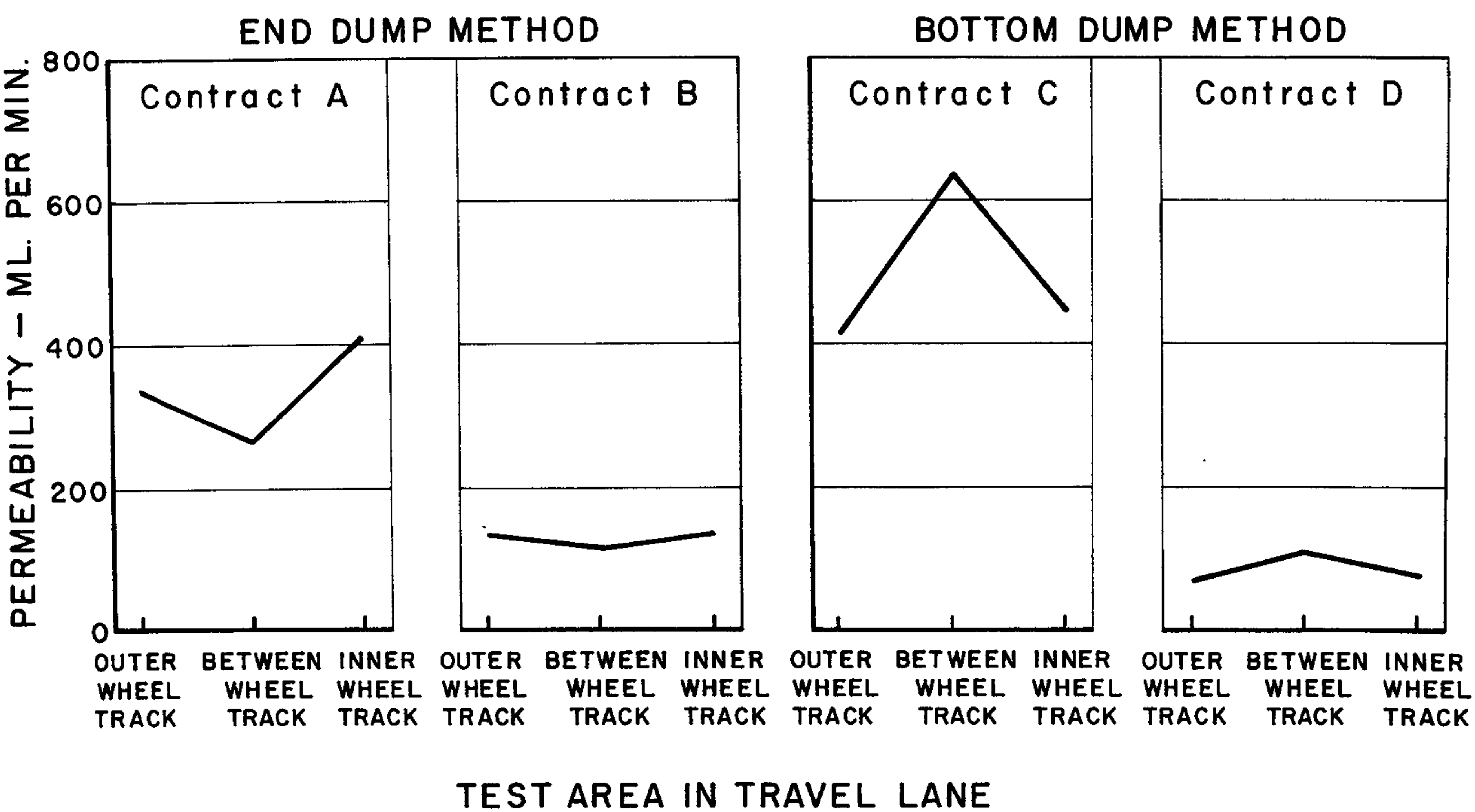
TABLE D

Reduction in Permeability Values
Following Application of a Slurry Seal

Test Condition	Station	New Pvt. Thickness	Permeability - Ml./Min.				
			Travel			Passing	
			Shldr.	O.W.T.	B.W.T.	B.W.T.	O.W.T.
New Pvt. immediately after const. Nov. 1957	603+00	2"	310	70	110	270	-
	603+25		-	100	130	140	-
	604+00		260	90	90	320	-
	606+50		230	90	100	270	-
	608+00		400	270	340	320	-
	Ave.		300	124	154	264	-
	589+00	3"	-	-	-	700	-
	590+00		-	-	500	480	-
	591+00		-	-	320	440	-
	591+89		-	-	400	500	-
	592+00		-	-	420	490	-
	593+00		-	-	360	-	-
	593+50		-	-	-	500	-
	594+00		-	-	360	350	-
	Ave.		-	-	393	494	-
	596+00	4"	-	-	250	-	-
	597+00		-	-	230	-	-
	598+00		-	-	500	-	-
	599+00		-	-	350	-	-
	600+00		-	-	750	-	-
	601+00		-	-	440	-	-
	Ave.		-	-	420	-	-
New Pvt. plus Slurry Seal immediately after completion Nov. 1957	604+00	2"	-	10	10	10	-
	604+25		-	10	10	10	-
	606+00		-	10	10	10	-
	606+50		-	10	10	10	-
	Ave.		-	10	10	10	-
	593+50	3"	-	10	10	10	-
	593+75		-	10	10	10	-
	Ave.		-	10	10	10	-
	598+00	4"	-	10	10	10	-
	598+25		-	10	10	10	-
	Ave.		-	10	10	10	-
New Pvt. plus Slurry Seal, Feb. 27, 1958 18" rain	604+00	2"	-	-	-	-	-
	604+25		-	-	-	-	-
	606+00		-	10	10	20	10
	606+50		-	5	10	15	10
	Ave.		-	7.5	10	17.5	10
	593+50	3"	-	10	10	20	15
	593+75		-	15	10	10	15
	Ave.		-	12.5	10	15	15
	598+00	4"	-	10	20	20	15
	598+25		-	10	10	10	15
	Ave.		-	10	15	15	15
New Pvt. plus Slurry Seal May 28, 1958	593+50	3"	-	10	10	10	10
	593+75		-	10	15	15	10
	Ave.		-	10	12.5	12.5	10
	606+50	2"	-	10	10	10	-
	606+75		-	5	10	15	-
	Ave.		-	7.5	10	12.5	-

Fig. 1

AVERAGE PERMEABILITY VALUES FOR TWO DIFFERENT PAVING METHODS



EFFECT OF COMPACTION PROCEDURES ON PERMEABILITY VALUES

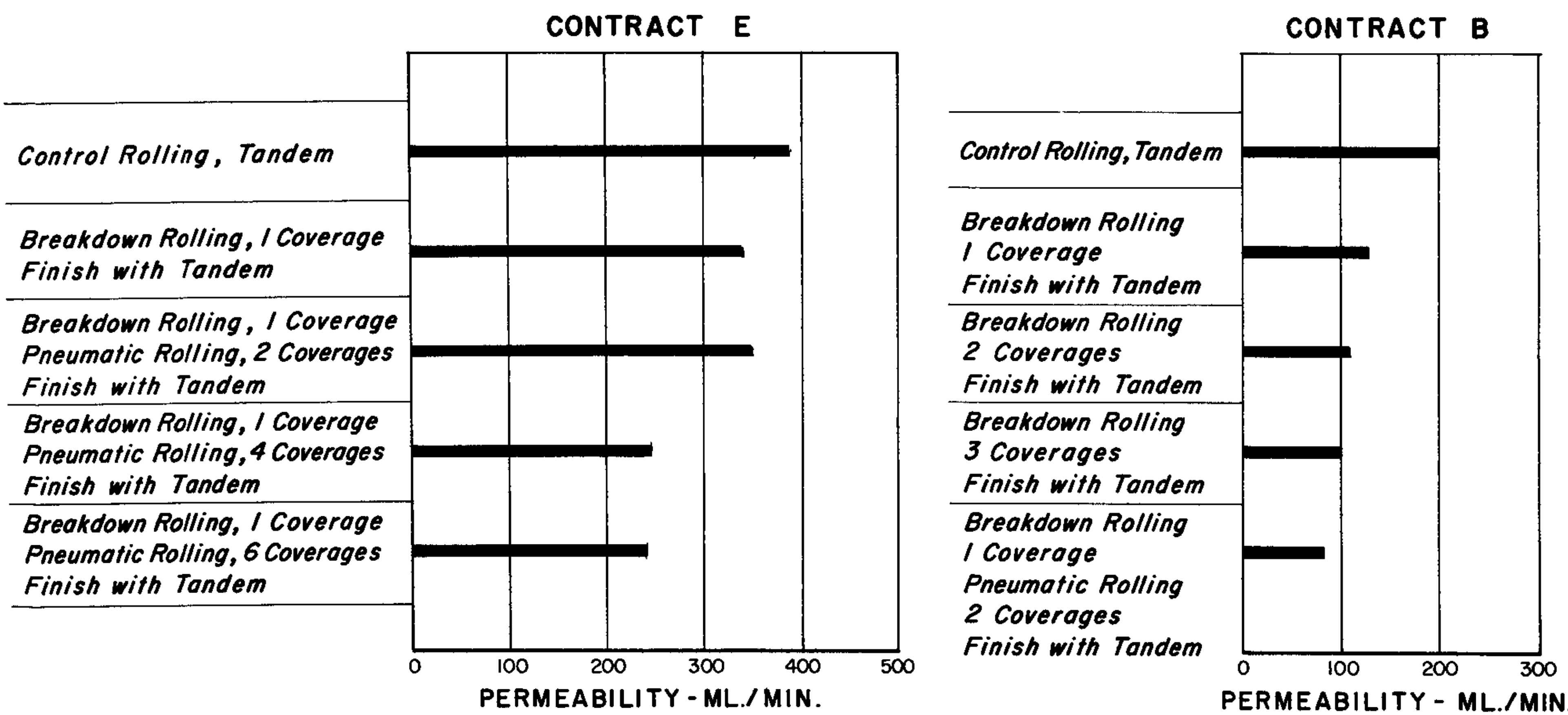


Fig. 2

AVERAGE PERMEABILITY VALUES OF A SECTION CONTAINING DIFFERENT ASPHALT CONTENTS.

CONTRACT A

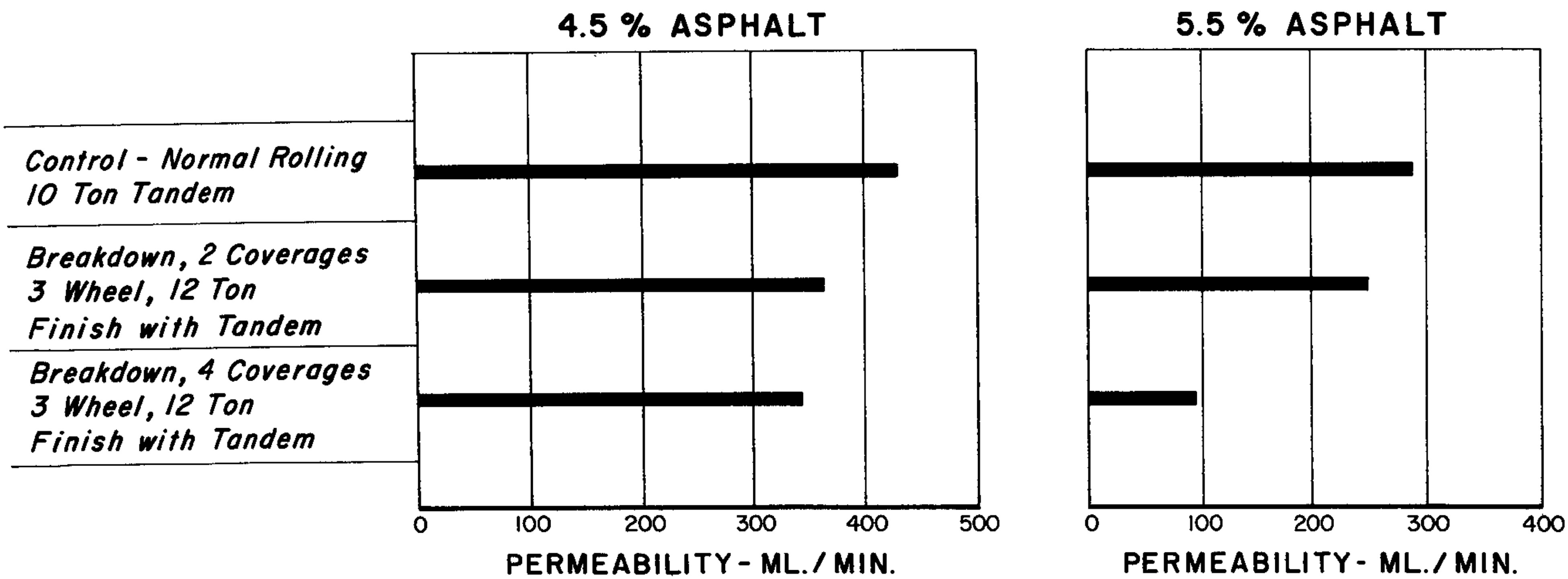


Fig. 3

Fig. 4

CHANGE IN PERMEABILITY VALUES CAUSED BY INCREASE AND DECREASE OF PAVEMENT MOISTURE AND TRAFFIC COMPACTION

CONTRACT A

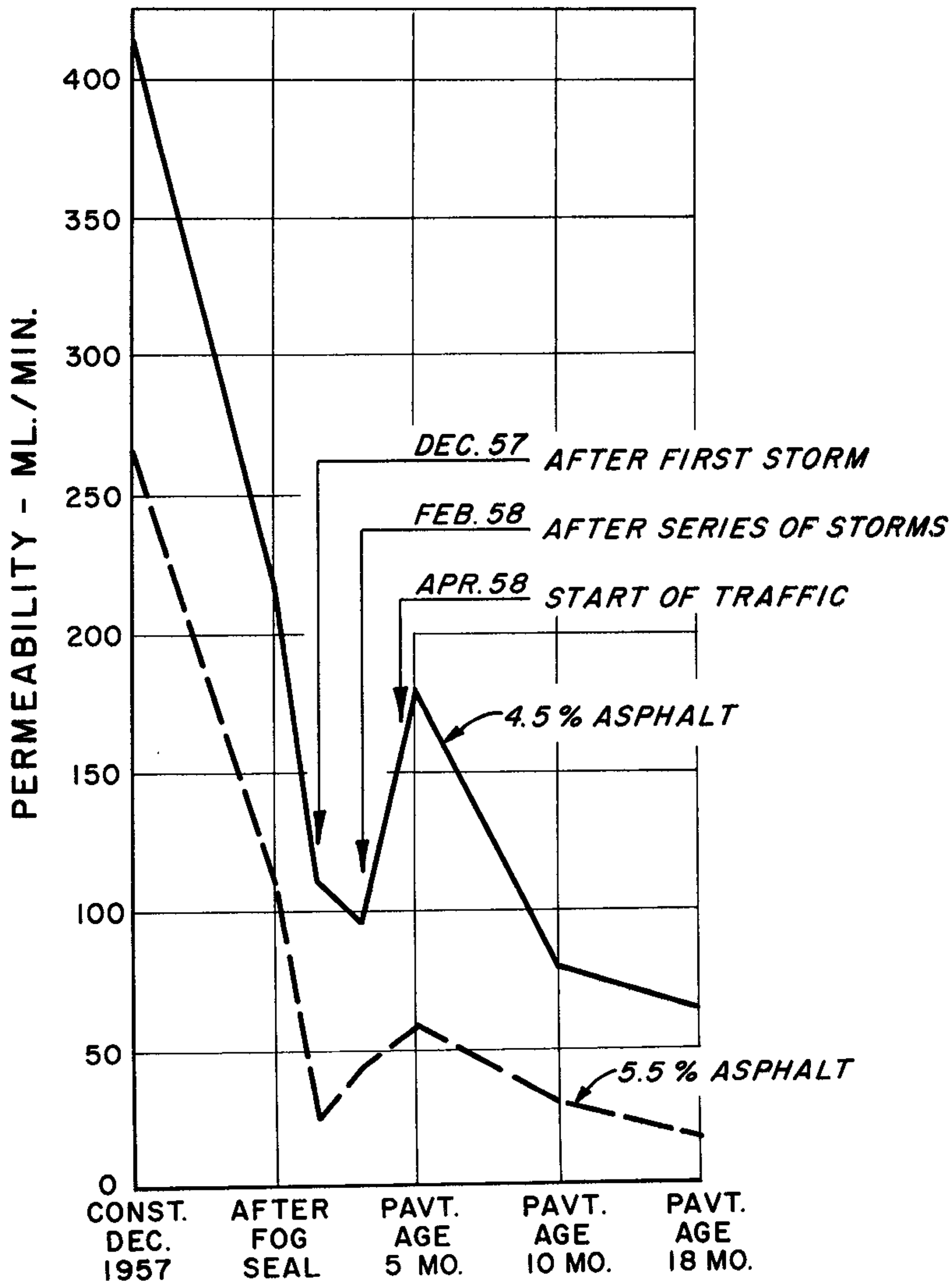
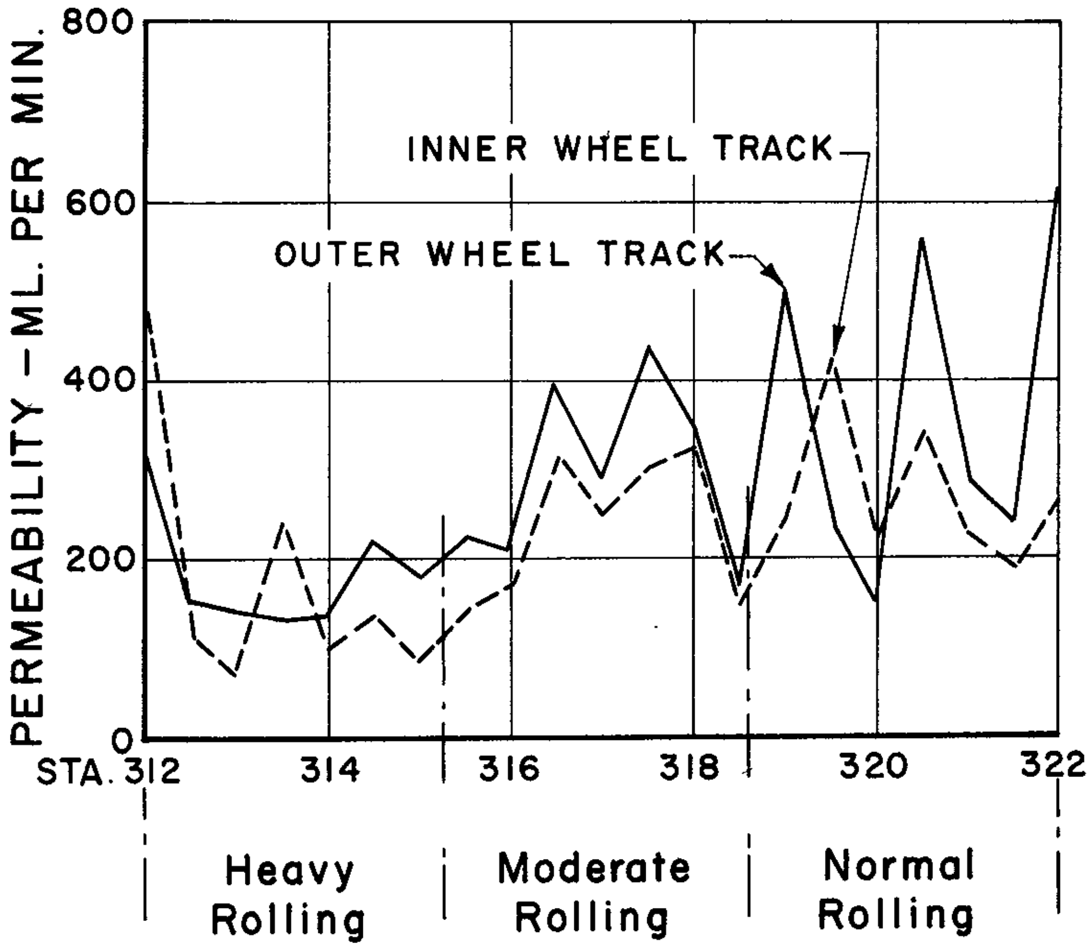


Fig. 5

PERMEABILITY VARIATIONS IN NORMAL CONSTRUCTION OPERATIONS ON CONTRACT A



CHANGE IN PERMEABILITY VALUES FOLLOWING FINAL ROLLING. NO TRAFFIC CONTRACT B

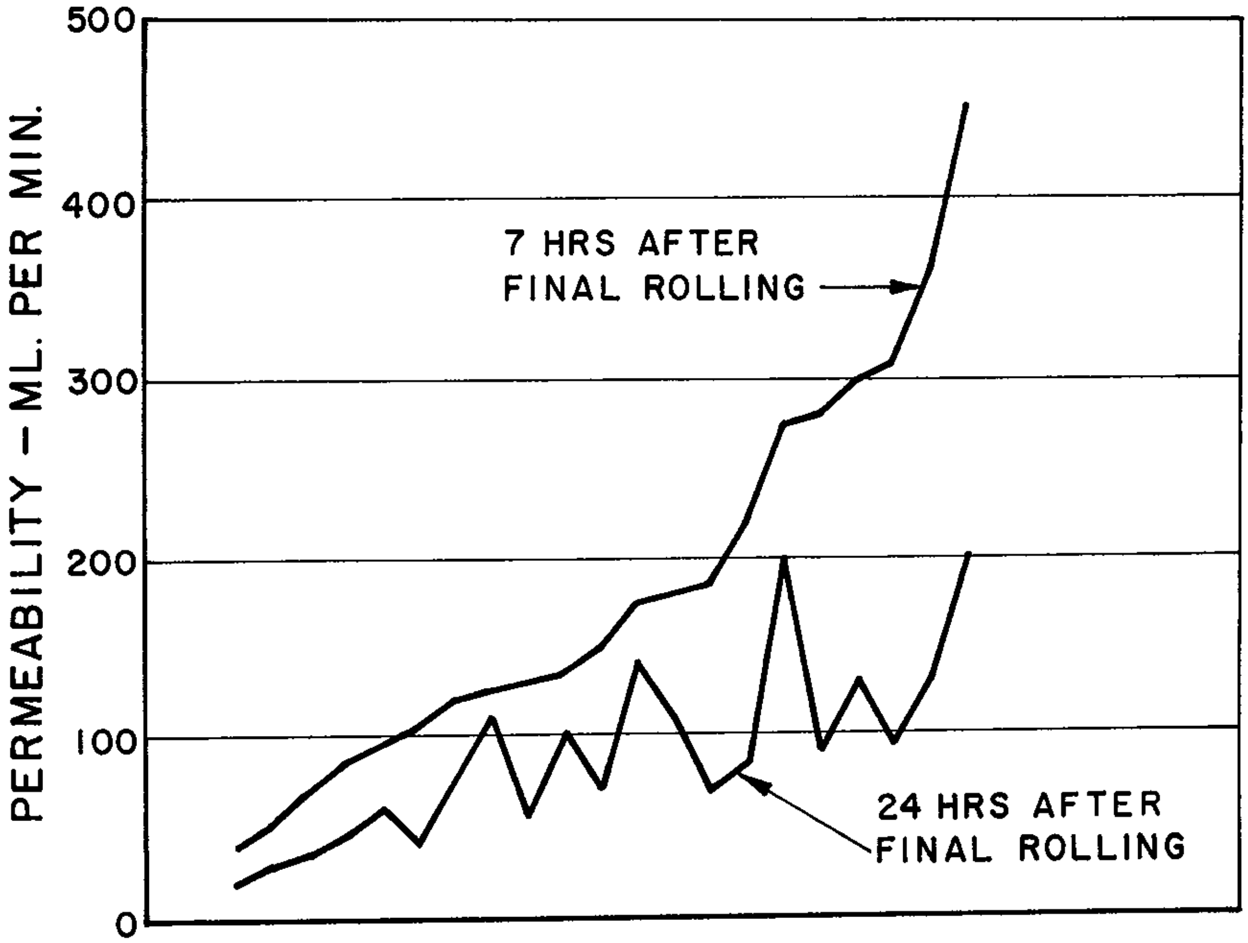
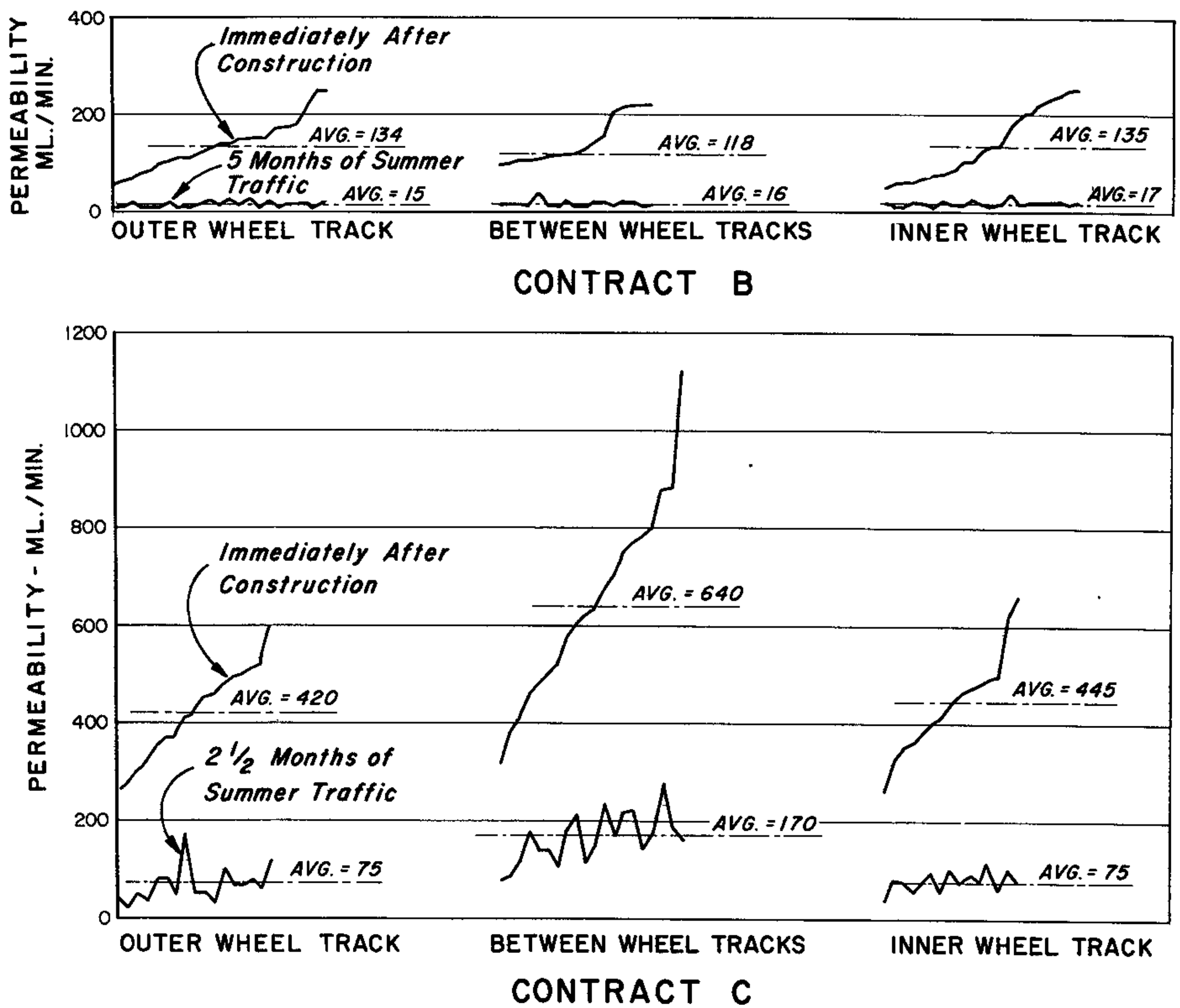


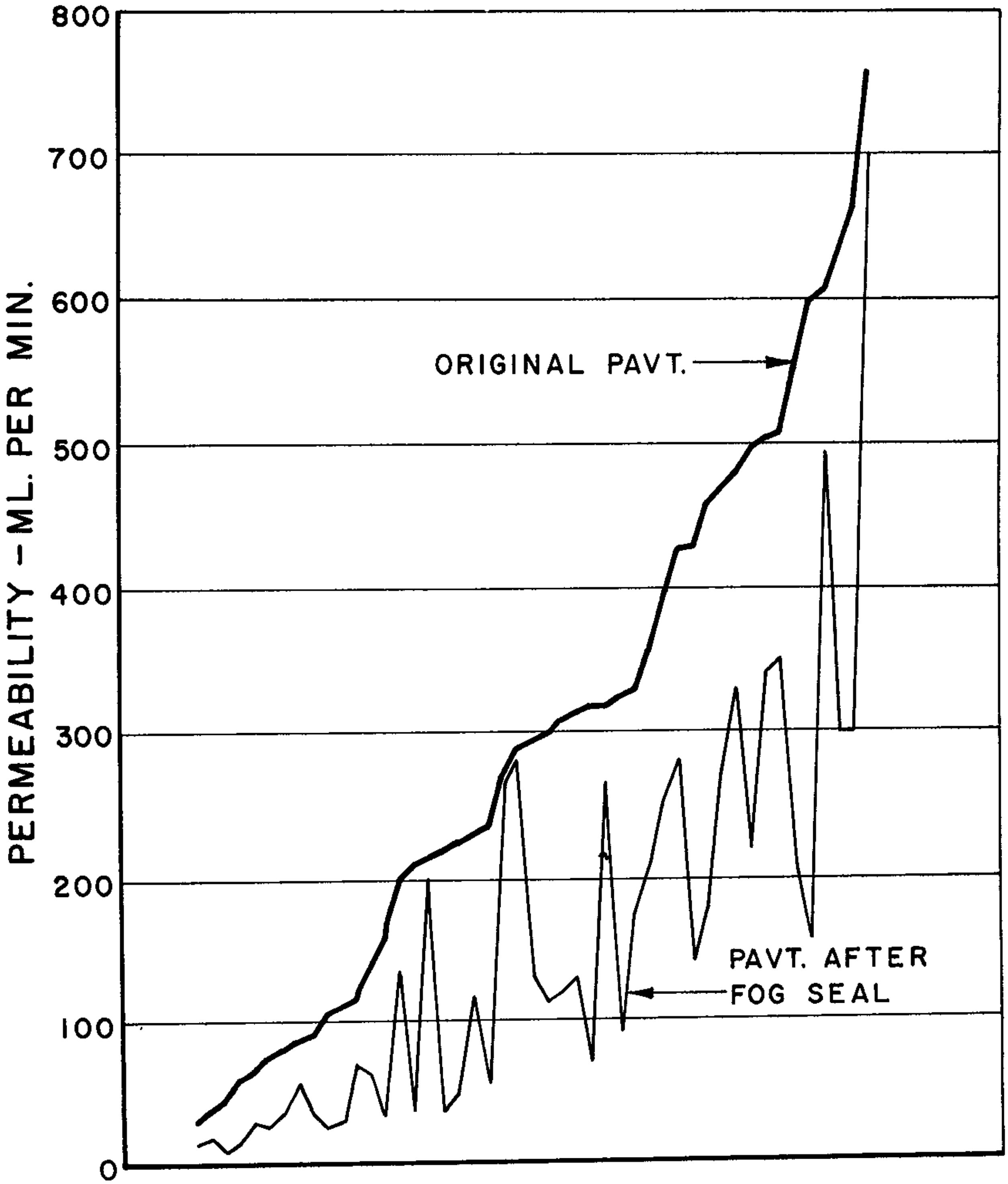
FIG. 7

CHANGE IN PERMEABILITY VALUES AFTER SUMMER TRAFFIC

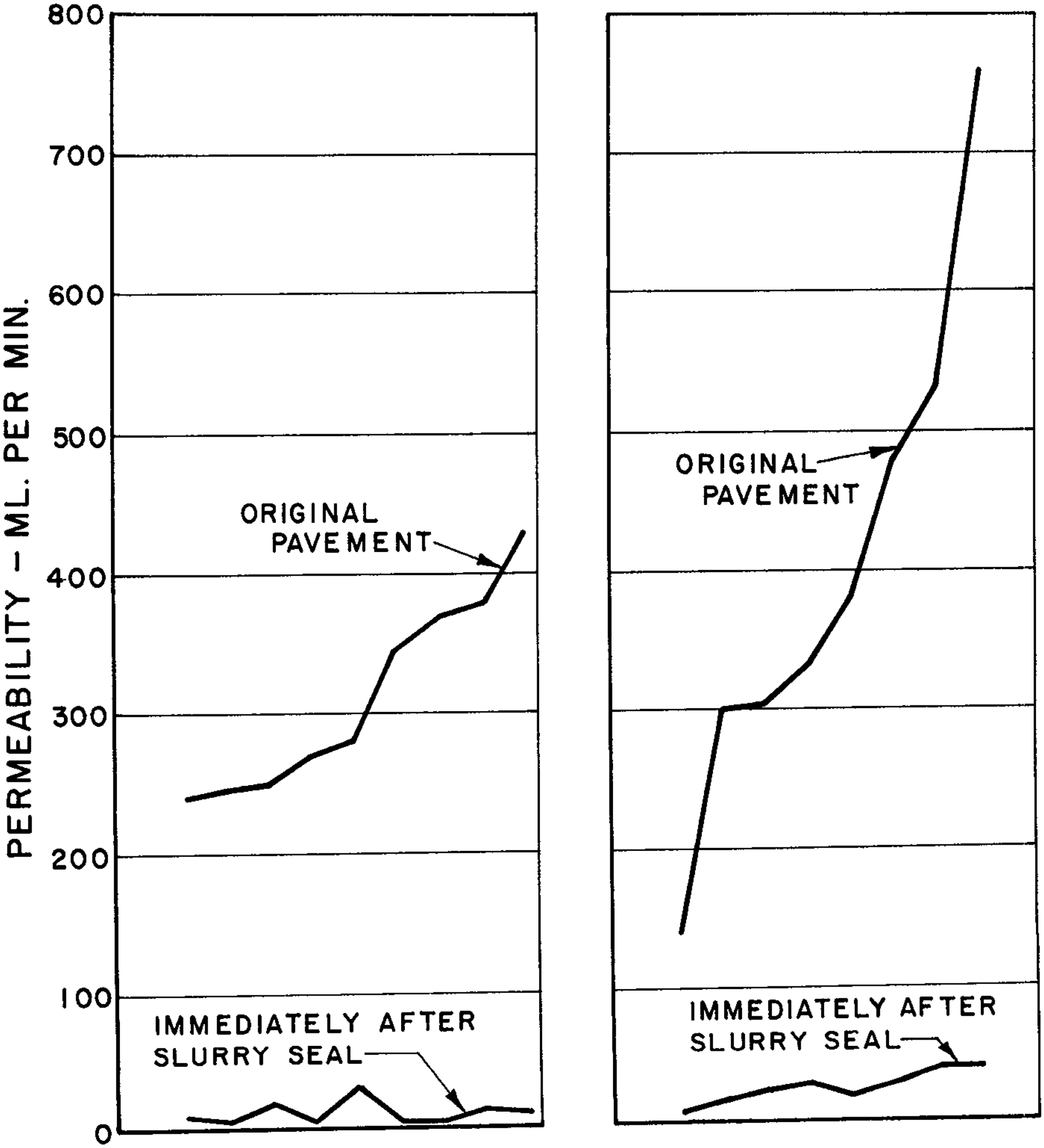
TRAVEL LANE



CHANGE IN PERMEABILITY VALUES AFTER APPLICATION OF A FOG SEAL CONTRACT A



REDUCTION IN PERMEABILITY VALUES FOLLOWING APPLICATION OF A SLURRY SEAL COAT CONTRACT F



Test Method No. Calif. 341-A
January, 1960
(4 pages)

State of California
Department of Public Works
Division of Highways
MATERIALS AND RESEARCH DEPARTMENT

METHOD OF TEST FOR MEASURING THE PERMEABILITY OF BITUMINOUS PAVEMENTS AND SEAL COATS

Scope

This method describes the procedure for determining the relative permeability of bituminous pavements and seal coats.

Procedure

A. Apparatus

1. 1—250 ml. special plastic graduated cylinder with valve.
2. 1—500 ml. special plastic graduated cylinder with valve.
3. 1—250 ml. Polyethylene graduated cylinder.
4. 1—500 ml. Polyethylene graduated cylinder.
5. 1—Calking gun with a 5-inch piece of ¼-inch copper tubing with cap.
6. 1—gal. Polyethylene bottle with handle and pouring spout.
7. 2—1 gal. friction top cans, one containing medium weight chassis grease.
8. 1—Polyethylene funnel 4½-inch diameter top.
9. 1—Stop watch with 60 second dial.
10. 1—Aluminum template, 6-inch diameter with handle.
11. 2—pieces yellow lumber crayon.
12. 1—6 foot folding Zig Zag Ruler.
13. 1—5-inch trowel.
14. 1—8-inch spatula.
15. 1—100 ml. glass graduated cylinder.
16. 1—1 qt. Polyethylene bottle for Aerosol Concentrate.

    The above items are furnished in a kit box.
17. 1—5 gal. Polyethylene Carboy container for storage of test solution.
18. 1—2 pound hammer.
19. 1—1-inch wide steel chisel.
20. 1—Face shield.

B. Materials

1. Medium weight chassis grease. One gallon is furnished with kit.
2. Wetting agent known as Aerosol OT 75% liquid. 1 quart is furnished with kit.
3. Supply of distilled water.
4. Supply of Premix patching material.

C. Preparation of Test Solution

Prepare test solution by mixing 95 ml. of Aerosol OT 75% liquid per 5 gallons of distilled water.

D. Method for Filling Calking Gun With Grease

1. Remove front cover of calking gun by turning counter clockwise.
2. Turn handle at rear of calking gun one half turn so that notched teeth on the rod are in an upward position and pull handle all the way out.
3. Fill gun with grease by using spatula and work as many air bubbles out of the grease as possible with the spatula.
4. Replace front cover and turn rear handle so that the notched teeth are in a downward position.
5. Pump calking gun handle until grease extrudes from copper tubing.
6. Always store calking gun in test kit with notches in an upward position and cap on copper tubing tip; this will prevent grease from being extruded from the gun during storage.

E. Test Procedure

The procedure for Dense Graded Asphalt Concrete Pavements and various types of Seal Coats is as follows:

1. With the crayon and template, draw a 6-inch diameter circle on the pavement.
2. Extrude grease from the calking gun on the circle. The diameter of the grease on the ring should be about ¼ of an inch; see Figure I.
3. Run finger around the outside edge of the grease ring, pushing a small amount of grease into the pavement. This will form a sealed reservoir for the test solution.
4. Fill the special plastic graduated cylinder and Polyethylene graduated cylinder with the test

solution. The Polyethylene cylinder is used for refilling the special cylinder when more solution is needed during test.

NOTE: In areas where the permeability of the pavement is below 250 ml/min. the 250 ml. graduated cylinders shall be used. The 500 ml. graduated cylinders are used in areas where the permeability of the pavement is greater than 250 ml/min.

5. Release valve at base of special plastic graduated cylinder, start stop watch and run solution from the special plastic graduated cylinder onto the area within the grease ring, keeping this area constantly covered with about a 1/16-inch film of the solution for two minutes; see Figure II. Refill the special plastic cylinder from the Polyethylene graduate if more solution is needed during test.

NOTE: At the end of the test the pavement inside the grease ring should have an unflooded wet appearance.

6. At the end of the 2 minute test period, determine the total amount of solution used.
7. Pick up grease with trowel and place in gallon can. Do not mix used grease with the new grease furnished with kit.

The procedure for pavements surfaced with Open Graded Asphalt Concrete is as follows:

1. With the crayon and template, draw a 6-inch diameter circle on the pavement.
2. Put on a face shield.
3. Use the hammer and chisel to chip away the open graded surfacing from around the 6-inch diameter circle forming a trough around the permeability test area; see Figure III. The trough around the ring shall be about 1-inch wide and shall extend into the dense graded portion of the pavement about 1/4-inch.
4. Use trowel for applying chassis grease in trough. The grease shall extend above the surface of the test area about 1/4-inch; see Figure IV. This will form a sealed reservoir for the test solution.
5. The test is then performed in the normal manner as previously described; see Figure V.
6. After test is completed remove grease, fill trough with Premix patching material and compact with hammer; see Figure VI.

F. Calculations

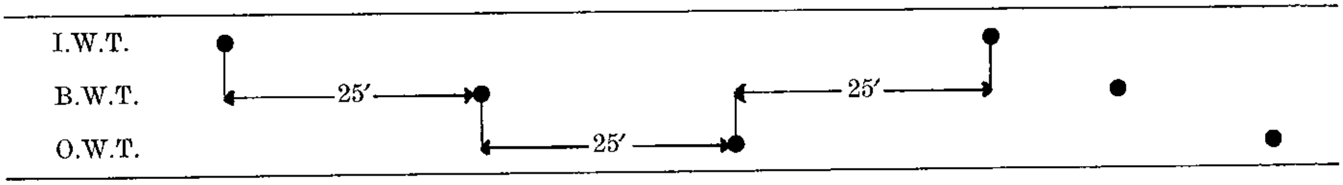
Divide the total quantity of solution used during the test period by two and record the relative permeability in mls/min. When the test is performed on an open graded surface, about 25 mls./min. of solution will be held by the open graded mix, even though no solution is entering the dense graded mixture. Subtract this amount from final result to obtain true value for dense graded mixture.

G. Hazards

1. The operator should always wear a suitable face shield when chipping open graded mix in preparation for the test.

H. Tentative Procedure for New Pavements

1. The following tentative procedure is recommended for obtaining an average permeability result on a given section of new pavement. In any travel lane, determine the permeability at 25 foot intervals in the outer wheel track (O.W.T.), inner wheel track (I.W.T.), and between the wheel tracks (B.W.T.), for a total of six readings. A diagram is shown below:



The six readings should be averaged to obtain the reading for the test area. This procedure should then be repeated at intervals of approximately 1000 feet.

2. In mountainous areas the above noted plan may have to be modified in order to provide a relatively flat area for testing.
3. When permeability studies are required after traffic action, it is advisable to test the passing lane in order to obtain the best indication of the relative permeability of the pavement.

REFERENCE

A California Method

End of Text on Calif. 341-A

PROCEDURE FOR DENSE GRADED ASPHALT CONCRETE PAVEMENTS AND VARIOUS TYPES OF SEAL COATS

FIGURE I

Forming grease ring.

FIGURE II

Applying test solution to pavement surface.

PROCEDURE FOR PAVEMENTS SURFACED WITH AN OPEN GRADED MIXTURE

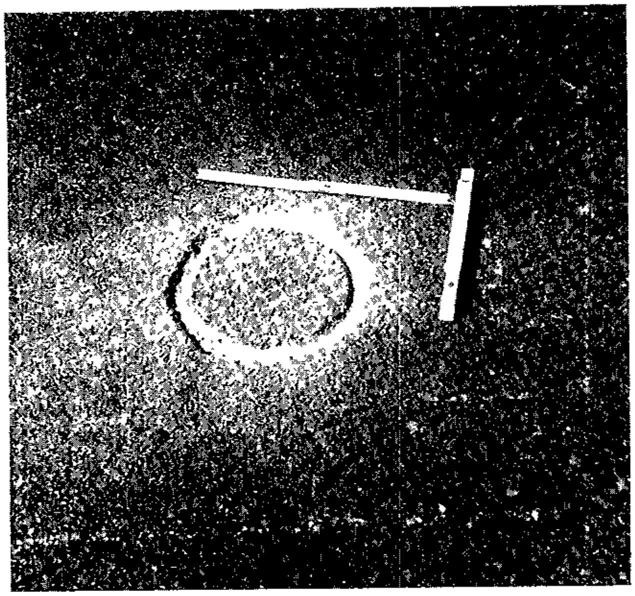


FIGURE III

Trough formed by removal of open graded mix. Note: Intact open graded mix within 6" diameter test area.

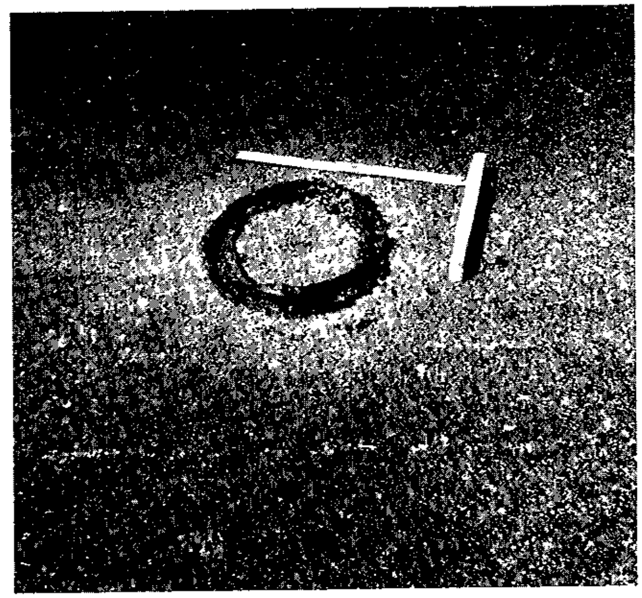


FIGURE IV

Grease ring formed around test area.

FIGURE V

Applying test solution to open graded surface within 6" diameter test area.

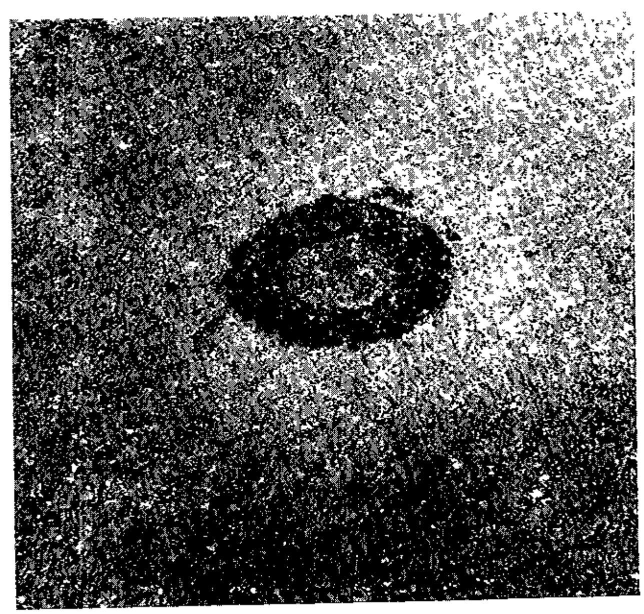


FIGURE VI

Trough area filled with premix patching material.